4 Quality Control Procedures

Contractor Personnel

QCP Manager
QCP Site Manager
Quality Control Technician

Milling

Milling Plan
Equipment
Testing

Process Balance

Transportation of Mixture

Truck Bed Cover
Unloading
Transfer Vehicles

Paving

Paving Plan
Material Feed System
Grade and Slope
Joints
Asphalt Materials

Joint Compaction

Materials Sampling and Testing

Mixture Properties
Mixture Temperature at Paver
Density
Coring
Smoothness

Response to Test Results

Pavement Smoothness

Documentation

Quality Control Plan

QCP Approval

QCP Addenda

CHAPTER FOUR: QUALITY CONTROL PROCEDURES

The foundation for a successful Quality Assurance program is the control maintained by the Contractor to assure that all materials submitted for acceptance conform to the contract requirements. To accomplish this, the Contractor is required to have a functional Quality Control Plan (QCP) to keep the process in control, quickly determine when the process goes out of control, and respond adequately to bring the process back into control.

This chapter includes the minimum requirements for maintaining quality control during production of QC/QA Hot Mix Asphalt. Acceptance test results by INDOT are shared with the Contractor; however, results of these tests should not be used for quality control purposes.

CONTRACTOR PERSONNEL

The Contractor personnel required to provide quality control on a QC/QA Hot Mix Asphalt contract includes a QCP Manager, QCP Site Manager, and a Quality Control Technician. One quality control person may perform the duties of more than one position.

QCP MANAGER

The QCP Manager is responsible for the overall administration of the QCP on the contract.

QCP FIELD MANAGER

The QCP Field Manager is responsible for the execution of the QCP and is the liaison with the PE/PS. This person is required to be a Certified HMA Field Supervisor and often is also the QCP Manager.

QUALITY CONTROL TECHNICIAN

The quality control technician is responsible for the following duties:

1) Quality control tests for temperature, density, and smoothness

2) Pavement samples for quality control and INDOT acceptance

3) Inspection to implement the QCP

MILLING

The Contractor is required to designate the procedures for milling the existing material to include as a minimum the general procedures, equipment, and testing that is conducted.

MILLING PLAN

The general procedures for asphalt milling, asphalt removal, PCCP milling, scarification and profile milling, and transition milling are required to be designated in the QCP.

EQUIPMENT

A description of the equipment required to mill, cut, and remove the existing material is required to be designated.

TESTING

The procedure for measuring the macrotexture of the milled surface in accordance with **ITM 812** is required (Figure 4-1). The purpose of this test is to measure the condition of the surface after milling in preparation for resurfacing with HMA.

Figure 4-1. Macrotexture Test

A minimum frequency of one macrotexture test is required. The requirements in accordance with Section **306** are as follows:

	Macrotexture
Asphalt Scarification & Profile Preparation	≥ 2.2 for single course overlays ≥ 1.8 for multiple course overlays
Asphalt Milling	≥ 2.2 for single course overlays ≥ 1.8 for multiple course overlays
PCCP milling	≥ 1.8

The procedure, frequency, and equipment for measuring the cross-slope and longitudinal surface finish of the milled material is also required.

PROCESS BALANCE

The procedures for balancing the HMA operation, include the production, transportation, placement, and compaction of the mixture. The purpose of this balancing is to assure that there is the proper amount of HMA to provide continual operation of the paver and that there is a sufficient number of rollers to provide an effective compaction production rate approximately equal to the paver speed. The QCP is required to state the methodology for balancing the operation to include the plant production, transportation, placement, and compaction of the mixture. One procedure to determine whether the HMA operation is balanced compares the plant production to the rate of mixture required to be delivered to the jobsite and the actual paver production rate to the effective compaction production rate (Figures 4-2 to 4-4). The following example explains the procedures required to balance the HMA operations.

Example

Verify if the process is in balance for the following given information:

Mix Delivery

Tons to be Placed	3000 t
Hours of Paving	10 h
Plant Rating	350 t/h
Average Truck Capacity	20 t
Truck Cycle (minutes)	
Delay at Facility	2
Load Time	3
Ticket & Tarp	2
Haul to Job	14
Delay on Site	5
Dump/Clean Up	5
Return Haul	14

Paving

Pavement width:	12 ft
Paving Thickness	2 in.
Minimum density	92% MSG
In-Place Target Density	94% MSG
Reference (Target) Density	143.0 #/ft^3
Paving Efficiency Factor	0.80

Compaction

Breakdown roller:	Dynapac CC-42A
Drum Width	66 in.
Maximum roller speed:	2 ½ mph
Vibrations/Minute	2700 VPM
Impact Spacing	10 impacts/ft
Number of Coverages to Achieve Density (Test Strip)	2
Roller Efficiency Factor	0.80

MIX DELIVERY PRODUCTION CALCULATION FORM

DATE: _____ PROJECT # _____

PROJECT: _____

Tons scheduled to be placed today (MIX):						**3,000**	t
Hours of paving scheduled (TIME):						**10**	h
Rate of mix needed to be deliverd to jobsite (H-RATE):							
= MIX / TIME =	**3,000**	/	**10**	=		**300**	tph
Rate of mix available from HMA facility (F-RATE):				=		**350**	tph
STOP: Is the H-RATE slightly greater than or equal to the F-RATE?							
Average Truck Capacity (SIZE):		=	**20**	net tons			
Total Truck Trips Needed (TRIPS):							
= MIX / SIZE =	**3,000**	/	**20**	=		**150**	TRIPS
TRUCK CYCLE (in minutes):							
Delay at Facility	**2**						
Load Time	**3**						
Ticket & Tarp	**2**						
Haul to Job	**14**						
Delay on site	**5**						
Dump/clean up	**5**						
Return Haul	**14**						
Total cycle in minutes	**45**	/ 60 min / h					
= Truck Cycle (CYCLE)			**0.75**	h / trip			
Number of Trips per Truck (LOADS):							
= TIME /CYCLE =	**10**	h /	**0.75**	h/trip	=	**13** (round down)	trips/truck
Number of Trucks Needed (TRUCKS):							
= TRIPS / LOADS =	**150**	/	**13**	=		**12** (round up)	TRUCKS
ARE TRUCKS x LOADS ≥ TRIPS?							
	12	x	**13**				
=	**156**	≥	**150**				

Figure 4-2. Mix Delivery Production Calculation

PAVING PRODUCTION CALCULATION FORM

DATE: _____ PROJECT # _____

PROJECT: _____

Tons scheduled to be placed today (MIX): **3,000** t

Hours of paving scheduled (TIME): **10** h

Rate of mix needed to be deliverd to jobsite (H-RATE):

= MIX / TIME = **3,000** / **10** = **300** tph

Paving Width (WIDTH): **12** ft

Paving Thickness (THICK): **2** in. / 12 in./ft = **0.17** ft

Compacted Mix Density (DENSITY):

Specification limits for density: Minimum = **92** Maximum = _____

The in-place target density should be above the Minimum: Target = **94**

DENSITY = Reference Density x % Target Density

= **143** pcf x **0.94** = **134.4** pcf

33.33 = Conversion factor (tons to pounds & hours to minutes)

Actual Paver Production Rate (P-RATE)

= MIX RATE x 33.33 / WIDTH / THICK / DENSITY

= **300** x 33.33 / **12.00** / **0.17** / **134.4**

P-RATE = **36** fpm

Paving Efficiency Factor (EFF1): **0.80** (recommended: 0.75 - 0.85)

Actual Paver Speed (PAVER):

PAVER = P-RATE x EFF1 =

36 x **0.80** = **29** fpm

Figure 4-3. Paving Production Calculation

COMPACTION PRODUCTION CALCULATION FORM

DATE: _____ PROJECT # _____

PROJECT: _____

Recommended Breakdown Rolling Speeds:

Static: 2 to 3-1/2 mph; **Pneumatic:**2 to 3-1/2 mph; **Vibratory:** 2 to 3[A]

Actual fpm	Speed (mph)	Reversal Factor	Effective fpm	Speed (mph)
176	(2.0)	-10%	158	(1.8)
220	(2.5)	-10%	198	(2.3)
264	(3.0)	-10%	238	(2.7)
308	(3.5)	-10%	277	(3.1)
352	(4.0)	-10%	317	(3.6)

A: Actual Speed for vibratory rollers can be based on the roller's operating frequency and an impact spacing of 10-12 impacts/ft. Use the following two lines to calculate these values.

ACTUAL SPEED = VPM **2,700**) / (**10**)impacts/ft **270** fpm/88 = **3.1** mph

EFF-SPEED = Actual - 10% = **270**) - 10% (**270**)impacts/ft ***243*** fpm/88 = **2.8** mph

Actual Roller Drum Width (DRUM): **66** in.

Effective Drum Width (EFF-DRUM): (To account for drum overlap, 6 in. is normally used)

EFF-DRUM = DRUM - 6 in. / 12 in/ft = **66** - **6** /12 in./ft = **5** ft

Paving Width (WIDTH): **12** ft

# of Passes to Cover Mat Width Once (PASS): = WIDTH / EFF-DRUM

PASS = **12** / **5** = (Round up to whole number) **3**

# of Repeat Coverages to Achieve Density (COVERAGE): **2** (From test strip)

Total # of Passes (T-PASS): = PASS x COVERAGE = **3** x **2** = **6**

(Note: If T-PASS is an even number, add 1 to T-PASS for make up pass)

Is T-PASS an even number? If Yes >>>> New T-PASS = T-PASS + 1 = **7**

Roller Efficiency Factor (EFF2): **0.8** (recommended 0.75 - .080)

Effective Compaction Production Rate (C-RATE):

C-RATE = EFF-SPEED x EFF2 / T-PASS = **243** x **0.80** / **7** = **28**

Compare: F-RATE **350** tph to H-RATE **300.0** tph: P-RATE **36** fpm to C-RATE **28** fpm

F-RATE	FACILITY (RATE OF MIX AVAILABLE FROM PLANT)
H-RATE	HAUL (RATE OF MIX NEEDED TO BE DELIVERED)
P-RATE	PAVER (PRODUCTION RATE)
C-RATE	COMPACTION (PRODUCTION RATE)

Figure 4-4. Compaction Production Calculation

TRANSPORTATION OF MIXTURE

The Contractor is required to designate the procedures for transportation of the HMA from the plant to the paver.

TRUCK BED COVER

The procedure for when waterproof covers are used and the person that directs their use is required.

UNLOADING

The procedures for unloading trucks and removing the remaining mixture from the truck bed and bed apron are required.

TRANSFER VEHICLES

The procedures for the use of Material Transfer Devices or Windrow Elevators, and the pans for crossing bridges with these devices is required.

PAVING

The Contractor is required to designate the procedures for placement of the HMA.

PAVING PLAN

The general sequence, the widths and depths of paving for each of the major courses, and the planned date for paving to begin and to be completed on the contract are required.

MATERIAL FEED SYSTEM

The procedure for processing the mixture through the paver is required.

GRADE AND SLOPE

The procedure for controlling the grade and slope, including a description of placing wedge and level courses, if applicable, is required.

JOINTS

The procedure for the construction of the longitudinal and transverse joints is required. The starting and stopping procedures of the paver for transverse joints is also required to be included.

ASPHALT MATERIALS

The source, source numbers, type, and grade of materials that are planned for use for the tack coat, prime coat, or seal coat are required.

JOINT COMPACTION

The Contractor is required to designate the procedures for compaction of the longitudinal and transverse joints.

MATERIALS SAMPLING and TESTING

The Contractor is required to designate the procedures for sampling and testing HMA and the frequency of tests. The sampling locations and procedures are not required to be the same procedures used for the acceptance samples.

MIXTURE PROPERTIES

The HMA plant is required to be a HMA Certified Plant in accordance with **ITM 583**. The location of the plant, owner, Producer name and plant number are required.

The laboratory, procedures done for quality control testing of the mixture, and the minimum frequency of samples is required.

MIXTURE TEMPERATURE at PAVER

The procedure for measuring the temperature of the mixture at the paver is required. The temperature is required to be taken immediately behind the paver prior to compaction at a minimum frequency of one test for each 1 hour of paving.

DENSITY

The procedure for measuring the density of the mixture utilizing a non-destructive technique is required. Density tests are required to be taken on the mainline and shoulders. The minimum frequency of tests is one test each 1000 yd^2. A nuclear test device, if used, is required to be calibrated in accordance with **ASTM D 2950** at a minimum frequency of once each 12 months. The nuclear gauge is required to be properly calibrated to the mixture being placed.

The procedure for monitoring the temperature of the mix during compaction to optimize the rolling pattern is also required.

Instead of a non-destructive testing device, an Intelligent Compaction (IC) roller meeting the Department requirements may be used to measure the stiffness and temperature of the mixture. A GPS radio and receiver unit shall be mounted on the IC roller to monitor the drum locations and track the number of passes of the roller. The IC roller shall include an integrated on-board documentation system that is capable of displaying real-time color-coded maps of IC measurement values including stiffness response values, location of roller passes, pavement surface temperatures, roller speeds, vibration frequencies, and amplitudes of the roller drums.

CORING

The plan for when cores are taken and the procedure for refilling the core holes is required.

SMOOTHNESS

The procedure for measuring the smoothness of the pavement is required. The annual certification of the profilograph in accordance with **ITM 901** is also required to be included.

RESPONSE TO TEST RESULTS

The Contractor is required to take corrective action when quality control test results exceed the established limits. The corrective actions are required to be designated in the QCP. As a minimum, corrective actions are required for the mixture tests from the pavement, the temperature measurements, and the density.

PAVEMENT SMOOTHNESS

The Contractor is required to designate the procedures for correcting the profile of non-complying pavement. Areas outside of the allowable tolerance of Section **401.18** are required to be corrected.

DOCUMENTATION

The test results for quality control and documentation of equipment are required to be maintained by the Contractor for a period of three years upon completion of the contract. The records, either electronic and/or hard copies, are required to be maintained at a readily accessible location for review by INDOT at any time. As a minimum, the documentation is required to include test results for the mixture, temperature, density, and smoothness tests of the HMA pavement. Also, documentation of the manufacture, model, and type of paver and rollers used each day of paving is required. Any modifications to this equipment are required to be noted.

QUALITY CONTROL PLAN

The Contractor is required to submit a QCP that is contract specific and states how the process control of materials, equipment, and operations are maintained. As a minimum, the QCP is required to include the following information for each contract.

1) The name, telephone number, duties, and employer of all quality control personnel necessary to implement the QCP. The minimum number of quality control personnel is required to include a QCP Manager, QCP Site Manager, and Quality Control Technician.

2) The procedure for milling to include the general procedures, equipment, testing for macrotexture, and testing for smoothness.

3) The procedure for balancing the HMA process to include plant production, number of trucks, paver speed, and compaction production rate procedure.

4) The procedure for transportation of the HMA to include the use of truck bed covers, truck unloading procedures, procedure for removal of mixture from the truck, and the use of material transfer vehicles.

5) The procedure for paving to include a paving plan, the material feed system, grade and slope control, joint construction, and use of asphalt materials.

6) The procedure for compacting longitudinal and transverse joints.

7) The procedures and frequency for sampling and testing the HMA, to include the mixture behind the paver, the temperature of the mixture at the paver, the density of the mixture, the coring procedure, and the procedure for measuring the smoothness.

8) The response to process control tests not within the established requirements for mixture, density, and smoothness tests.

9) The procedure for documentation of quality control tests and the equipment used on the contract.

QCP APPROVAL

The QCP is required to be submitted to the PE/PS for review at least 15 calendar days prior to commencing HMA operations. The Contractor is required to sign and date the QCP at the time of submittal to the PE/PS. The PE/PS signs and dates the QCP if the contents of the QCP are in compliance with the above-noted requirements. HMA operations are not allowed to begin before the QCP has been accepted.

QCP ADDENDA

The QCP is required to be maintained to reflect the current status of the operations, and revisions are required to be provided in writing prior to initiating the change. The change may not be implemented until the revision has been accepted.